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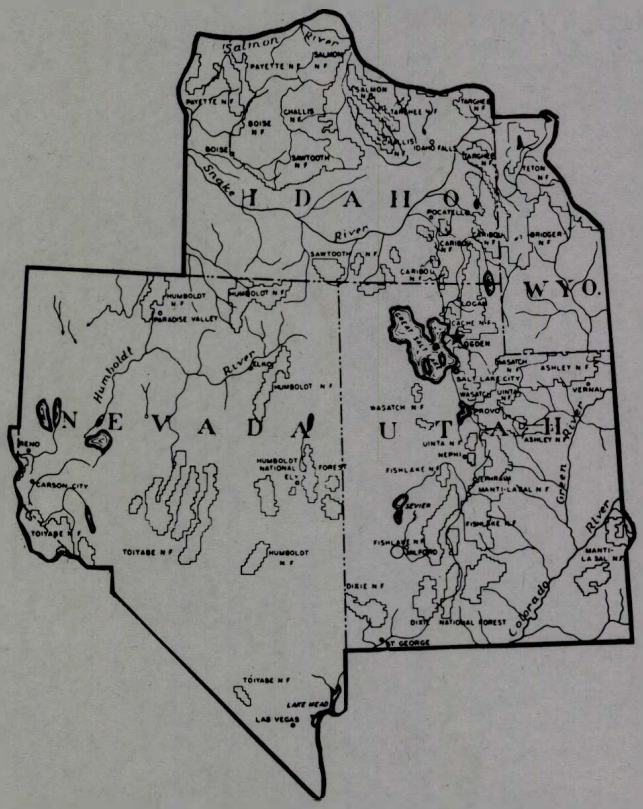
SPRUCE BUDWORM INFESTATIONS

FOREST SERVICE REGION 4

November 1963



BRANCH OF FOREST INSECT AND DISEASE
PREVENTION AND CONTROL

DIVISION OF TIMBER MANAGEMENT

Forest Service
U. S. Department of Agriculture
Ogden, Utah

SPRUCE BUDWORM INFESTATION
Forest Service Region Four

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INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.), is distributed throughout fir stands of the United States and Canada. This insect was first found in the West in about 1915, but was not recorded as an important pest until 1923, at which time two outbreaks were reported in separate areas in Idaho. The insect is believed to be indigenous to the West.

The spruce budworm is a major pest of the Douglas-fir, Engelmann spruce, and true firs of the southern Idaho portion of United States Forest Service, Region Four. The present epidemic extends over parts of six National Forests and has been developing since 1958. A previous epidemic, which covered much of the same area, started in 1951; in 1954 a control program was initiated which was carried through 1957. Altogether, over 2.2 million acres were sprayed. No control has been undertaken since 1957, and the budworm population has been increasing steadily since then.

In the summer of 1963, slightly more than 200,000 acres were treated by aerial application of DDT. The dosage rate varied from $\frac{1}{2}$ to 1 pound of DDT per acre, and was applied by both fixed-wing aircraft and helicopter. Nearly all of the acreage sprayed was on the Targhee National Forest.

METHODS

A combination of air and ground techniques was used to gather data for the evaluation of the present spruce budworm situation. Mapping the infestation boundaries and delineation of broad classes of current damage was accomplished by aerial surveys. The groundwork involved examination of larval populations, pupal case counts, and an egg mass survey. The larval population survey was accomplished by using the sequential plan developed by Cole.[1] Pupal density data were collected following Terrell[2] sequential table that categorizes expected damage into four classes. The egg mass survey procedures were adopted from suggestions and findings of Carolin and Coulter.[3]

One thousand square inches of foliage were used as the sampling unit for the egg mass survey. Each sample was put into a separate 50 pound flour sack. At least five samples were collected from each sampling point. The bags of foliage were picked up twice weekly by a chartered Cessna 205 aircraft and flown directly to Ogden where the samples were immediately put into cold storage. By using flour sacks, it was possible to transport between 125 to 175 samples per planeload. All egg mass counts were made in the Region's laboratory at Ogden, Utah under the direct supervision of an experienced laboratory technician. Estimation of eggs per mass was obtained by using Bean[4] and Terrell.[2]

The 1962 prediction, based upon egg mass count, proved accurate for nearly all of the 1.6 million acres infested in the Region last year. Therefore, last year's egg density per mass was used to adjust this year's egg mass number. This was done by computing the number of eggs present in 1963 and dividing the total by the number of eggs per mass last year. The 1964 damage level was predicted by using the adjusted egg mass number per thousand square inches of foliage.

1/ Walter E. Cole, Sequential Sampling in Spruce Budworm Control Projects, Forest Science, Volume 6, Number 1, March 1960.

2/ Tom T. Terrell, Techniques of Spruce Budworm Surveys in the Northern Rocky Mountain Region, 14 pp., 1959 Progress Report. U. S. Department of Agriculture, Intermountain Forest and Range Experiment Station, July 1960.

3/ V. M. Carolin and W. K. Coulter, Research Findings Relative to the Biological Evaluation of Spruce Budworm Infestations in Oregon, 1-39 pp. U. S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station, 1959.

4/ James L. Bean, A Method for Estimating the Number of Spruce Budworm Eggs per Egg Mass, Journal of Economic Entomology, Vol. 54, No. 5, p. 1064, October 1961.

CURRENT CONDITIONS

The 1963 infestation covers a total of 1.6 million acres of damage visible from the air. One and six tenths million acres were also reported having suffered visible defoliation in 1962. Of the total acreage presently infested, slightly more than 60 percent was heavily defoliated compared to 48 percent in 1962.

A good share of the aerial surveys were flown at least thirty days later than the optimum date for observance of defoliation. There is, therefore, some question if all of the light and medium defoliation was visible. Consequently, it is entirely possible the total area infested may exceed the 1.6 million acres reported.

The following table gives a comparison of the acreage by damage classes from 1960 through 1963:

	Damage Class in Acres			
Year	Light	Medium	Heavy	Total
1960	297,000	80,000	19,000	396,000
1961	643,000	229,000	553,000	1,425,000
1962	480,000	373,000	788,000	1,641,000
1963	357,760	276,550	988,788	1,623,098

Slightly over 200,000 acres of the 1963 infestation were sprayed this year.

In this report the three damage classes used refer only to current defoliation. The classes are defined by estimated percent of current foliage destroyed, and are as follows: Light - any defoliation visible from the air, usually between 20 and 50 percent. Medium - 50 to 75 percent defoliation. Heavy - over 75 percent defoliation.

In reality the present budworm epidemic involves three separate and distinct infestations. They are discussed in this report under the following headings: Salmon River infestation, Targhee National Forest infestation, and Sawtooth National Forest infestation.

Salmon River Infestation

The Salmon River infestation covers parts of the Salmon, Challis, Payette, and Boise National Forests. It follows the main Salmon River from just below Dillinger Creek in the Idaho Primitive Area, upriver nearly to the town of Challis, Idaho. In addition, the main side drainages (Middle Fork, Panther Creek, Lemhi River, and North Fork) are infested. There are also several small spot infestations - one to the south in Ziegler Basin on the Challis National Forest, and to the west in Sleepy Creek, southeast of Mackay Bar on the Payette National Forest, and just east of Yellow Pine on both the Payette and Boise National Forests.

Acreage by Forest and damage classes is given in the following table:

1963 Salmon River Infestation

National Forest	Light	Medium	Heavy	Total
Salmon	89,920	107,910	679,348	877,178
Challis	73,760	69,920	97,440	241,120
Payette	116,000	35,520	22,400	173,920
Boise	2,400	10,080	43,680	56,160
Totals	282,080	223,430	842,868	1,348,378

The 1963 infestation covers 1,311,870 acres which is slightly less than the 1962 acreage of 1.4 million acres. However, due to the lateness of the aerial survey and the occurrence of heavy rains before the survey, it is quite possible some areas receiving light to moderate defoliation were not detected. While the acreage infested remained about the same, the severity of damage increased over last year showing a jump from 732,000 to 843,000 acres of heavy defoliation.

A cooperative administrative test was carried on this year in Hughes Creek, a side drainage of the North Fork of the Salmon. The purpose of the test was primarily to determine what effects various dosages and methods of application would have on salmon fry and other game fish inhabiting live streams. The test area covered 16,500 acres.

Approximately 298,620 acres of the Salmon River infestation lie within the Idaho Primitive Area. This includes a major portion of the infestation on the Payette and Boise National Forests as well as a small amount of the total infestation on the Salmon and Challis National Forests.

Pupal density counts, defoliation measurements and egg mass density surveys were conducted throughout the infestation except for the primitive area where time prevented making either egg mass surveys or other ground evaluations. A summary of the evaluation data is shown in the following tables:

SALMON NATIONAL FOREST
1963 Spruce Budworm Evaluation

North of Salmon River

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level Egg mass prediction	Expected
Colson Creek	> 90%	II	6.6	55.23	12.18	51-90%	51-90%
West Fk. Indian Creek	75-90%	II	8.6	56.60	16.22	90-100%	> 90%
Dahlonega Creek	> 90%	III	7.0	51.48	12.00	51-90%	> 90%
Carmen Creek	75-90%	III	2.6	49.92	4.33	15-25%	51-90%

Panther Creek Area

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level Egg mass prediction	Expected
Panther Creek	-	-	1.8	41.75	2.46	> 15%	25-50%
Mocassin Creek	75-90%	-	6.4	45.16	9.45	51-90%	51-90%
Blackbird Creek	-	-	7.6	49.55	12.60	51-90%	51-90%
Napias Creek	> 90%	II	8.2	45.70	12.50	51-90%	> 90%
Copper Creek	> 90%	III	4.4	46.58	6.85	25-50%	51-90%
Porphyry Creek	75-90%	II	2.8	36.45	3.42	15-25%	51-90%
Camp Creek	> 90%	III	-	-		-	> 90%
Silver Creek	> 90%	-	3.4	43.27	4.90	15-25%	> 90%

SALMON NATIONAL FOREST
1963 Spruce Budworm Evaluation

Main Salmon River Area

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level Egg mass prediction	Expected
Derian Creek	>90%	-	14.8	53.71	21.50	90-100%	>90%
Williams Creek	>90%	II	-	-	-	-	50-75%
Hat Creek	>90%	-	5.2	43.76	7.08	25-50%	>90%
North Fork of Cow Creek	75-90%	II	1.2	26.69	1.07	>15%	25-50%
Poison Creek	>90%	II	5.0	54.80	9.13	51-90%	51-90%

Lemhi River Area

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level Egg mass prediction	Expected
Bear Valley Creek	75-90%	II	4.5	40.94	6.15	25-50%	50-75%
Basin Creek	50-75%	-	1.6	43.35	2.30	> 15%	50-75%
Timber Creek	> 90%	-	7.2	49.32	11.80	51-90%	51-90%
Muddy Creek BLM	25-50%	I	3.8	54.90	6.95	25-50%	25-50%
Agency Creek	75-90%	II	13.8	49.42	22.70	90-100%	> 90%
Cow Creek	75-90%	II	14.4	52.56	25.23	90-100%	> 90%

CHALLIS NATIONAL FOREST
1963 Spruce Budworm Evaluation

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level	
						Egg mass prediction	Expected
Meyers Cove	50-75%	-	3.6	52.58	6.33	25-50%	50-75%
Challis Creek	> 90%	-	2.8	46.95	4.28	15-25%	50-75%
Lower Morgan Creek	50-75%	-	1.0	50.48	1.60	>15%	50-75%
Morse Creek	> 90%	-	8.4	55.97	15.65	90-100%	> 90%

The size and shape of the egg masses found this year were quite different from those present last year. This year, the average number of eggs per mass was 50 compared to 30 for the previous year. Last year nearly all of the egg masses had only two rows of eggs. This year 73 percent of the egg masses contained three rows of eggs and an additional 7 percent had four rows of eggs. The average length for all egg masses was 9.9 mm.

The last column of the tables is a reflection of the entomologist's opinion based upon egg mass and pupal density data tempered by on-the-ground interpretation. A similar prediction was included last year in the biological evaluation report. With one exception, damage measurements in 1963 proved the predictions accurate. The exception was Moccasin Creek where the egg mass prediction was for less than 15 percent defoliation. The entomologist's prediction was for 50-75 percent defoliation, but 1963 measured damage was greater than 90 percent. On approximately 50 percent of the areas sampled, the entomologist's predictions this year differ from the egg mass data; in each case heavier defoliation is predicted than indicated by the egg mass survey.

Some examples of sampling variation and other irregularities will explain the reasoning behind the entomologist's predictions and provide a basis for judging the validity of the interpretations. In some areas, there was considerable variation in the distribution of the egg masses; e.g., 90 percent of the egg masses were found on one sample, whereas three of the five samples did not contain a single egg mass. This, of course, may be an indication that five collections of 1,000 square inches each may not produce a representative sample. In other areas, a majority of the type was Engelmann spruce and true fir, but since damage prediction tables are not available for spruce and fir species, only Douglas-fir was sampled. In these cases, greater reliance was placed on pupal case counts than on egg mass densities. On some units, because of extremely rough terrain, inaccessibility and time limitations, the samples were not obtained within the heavily infested solid stands of timber. A few areas had recently been logged and the remaining young trees were below the height from which the egg mass samples were taken. On-the-ground examinations showed the presence of large numbers of egg masses on the small trees. In addition, in some areas, moths observed during the pupal case counting indicated a majority were depositing eggs above the portion of the tree used for the egg mass survey.

In 20 out of 22 sampling areas, defoliation is expected to exceed 50 percent, and in over half of the areas, defoliation should be greater than 90 percent. Considerably over half of the infested area has been subjected to greater than 90 percent defoliation for at least the last three years. If the prediction for 1964 proves accurate, defoliation will again exceed 90 percent within the areas that have been heaviest hit in the past. In many of the areas subjected to heavy defoliation for several years, some tree killing has occurred and much more is expected. In addition, on a majority of the surviving trees, many of the branches did not produce a full complement of buds this year. Top and branch killing is also prevalent.

Targhee National Forest

The budworm has been active on the Targhee National Forest for the last eight years. In 1957, a total of 118,365 acres of budworm infestation were sprayed with one pound of DDT per acre. Excellent control was obtained on the area sprayed but the epidemic tendencies of the budworm population in the general vicinity remained. Consequently, some reinfestations occurred and some new areas became infested. By 1959, 204,000 acres were infested, of which 4,000 acres suffered greater than 90 percent defoliation. In 1960, the acreage defoliated dropped to 131,000 acres, but the spread resumed in 1961 and continued through 1962.

This year, slightly over 200,000 acres of budworm infestation on the Targhee National Forest were included in the Region's budworm control project. As was expected, the spray program did not materially reduce the damage caused by the 1963 populations. However, as measured by larval mortality, excellent control was obtained. The results of an extensive egg mass survey also reflect the reduction of budworm population caused by the control project. Altogether, 19 areas were sampled. In the areas where the DDT dosage was varied or where non-spray areas around streams existed, a separate set of samples was taken for each segment. In most cases, egg mass densities did not vary significantly in a given area even though more than one dosage rate and method of application were used. This is probably more a reflection of the mobility of the insect in the adult stage rather than the influence of the insecticide dosage variation. The egg mass densities reported in the table, therefore, are averages of all samples for each area. West Rattlesnake and Dairy Creek did show significant variations and the data for these areas are reported separately by samples in the table.

On a majority of the areas, defoliation is expected to be less than 25 percent, but on four units defoliation will range from 25 to 75 percent. In three areas totaling approximately 22,000 acres, egg mass density indicates defoliation in 1964 will be between 51 to 90 percent. These were among the hardest hit areas last year, where the budworm population was extremely heavy. Thus, in spite of 95 percent or better control, a sufficient population survived to deposit enough eggs to indicate defoliation will exceed 50 percent next year.

Considering the Targhee National Forest infestation as a whole, control action next year does not seem to be advisable. However, since some budworm population is still present throughout the infestation and there are three separate hot spots, it may become necessary to do some control work the year after next. Otherwise, a general reinfestation of the Douglas-fir stands on the northern portion of the Targhee National Forest may occur. Subsequent evaluations will provide the basic criteria to determine the need for additional control action against this infestation.

TARGHEE NATIONAL FOREST
1963 Spruce Budworm Evaluation

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level Egg mass prediction	Expected
Twin Creeks (Sevin Ck.Area)	25-50%	-	2.9	50.29	4.38	15-25%	15-25%
Sevin Test Area #32	<25%	-	.8	43.35	1.04	<15%	<15%
Sevin Test Area #30	<25%	-	.8	44.72	1.07	<15%	<15%
Yale Creek	-	-	.8	51.77	1.24	<15%	<15%
Willow Creek	50-75%	-	2.9	49.30	4.26	15-25%	15-25%
Snyder Creek	25-50%	-	1.0	55.97	1.68	<15%	<15%
Taylor Creek	75-90%	-	1.1	43.10	1.42	<15%	<15%
West Fork of Dry Creek	75-90%	-	1.2	46.25	1.66	<15%	<15%
Kay and Cottonwood Creeks	75-90%	-	1.2	55.24	1.98	<15%	<15%
West Camas Creek	90%	-	8.0	49.00	11.76	51-90%	51-90%
Bear Gulch	90%	-	3.2	58.44	5.60	25-50%	50-75%
West Rattlesnake	>90%	-					
½ lb. spray			.2	29.63	.18	<15%	<15%
1 lb. spray			5.2	53.48	8.32	25-50%	50-75%
Dairy Creek	>90%						
No spray		-	.4	24.14	.29	<15%	<15%
½ lb. spray		-	4.4	58.03	7.66	25-50%	25-50%
1 lb. spray		-	9.4	52.09	14.66	51-90%	51-90%
Lower Picnic Hollow	>90%	-	3.4	52.65	5.37	25-50%	25-50%
Upper Picnic Hollow	>90%	-	6.0	51.98	9.36	51-90%	51-90%
Pleasant Valley Creek	50-75%	-	1.3	46.50	1.8	<15%	15-25%

Sawtooth National Forest Infestation

The Sawtooth National Forest infestation in the vicinity of Fleck and Little Smokey Creek on the South Fork of the Boise River has been in existence for nearly ten years. During this period there have been several rather sudden population declines. On two occasions the population reductions took place when the budworm was in the moth stage. The reductions were caused by torrential rainstorms that drowned a high proportion of the moths before the eggs were deposited. In 1961, a definite reduction in total infested acreage occurred, but there was a decided increase in acreage heavily defoliated.

The 1962 survey showed a threefold increase in total acreage over 1961. The egg mass survey predicted over 90 percent defoliation would occur in 1963 over nearly all of the 41,000 acres infested. Damage surveys in 1963 show that throughout the area infested in 1962, defoliation greater than 90 percent did occur.

Unfortunately, the 1963 aerial survey of the infestation was delayed approximately 30 days beyond the period when budworm defoliation is clearly visible from the air. In addition, heavy rains over much of the infestation occurred prior to the survey and these could well have washed off some or most of the brown partially consumed needles. Consequently, there is some question whether the aerial survey map portrays an accurate picture of the Sawtooth infestation. It is very possible some areas mapped as receiving medium defoliation may have suffered greater defoliation, in fact, ground sample plots in one area mapped as medium showed greater than 90 percent defoliation. The ground crews reported that nearly all of the areas designated by the aerial observer as moderate actually sustained greater than 90 percent defoliation. Likewise, areas mapped as lightly defoliated probably were at least moderately defoliated and some lightly defoliated areas may not have been visible at all from the air. Nevertheless, this year's aerial survey shows 60,160 acres of infestation--this is an increase of 21,000 acres over last year. The following table shows the acreage by damage level as seen from the air for the last three years.

SAWTOOTH NATIONAL FOREST

Year	Light	Medium	Heavy	Total
1961	5,000	3,000	5,000	13,000
1962	4,000	10,000	27,000	41,000
1963	14,720	25,440	20,000	60,160

Five randomly selected plots were used to gather data to predict next year's population level and subsequent damage. Pupal density counts were made when approximately 90 percent of the moths had emerged. The

counts showed that pupal densities fell within class three on three areas and class two on two areas. Only pupae cases from which adult moths had emerged were used in the density counts. Approximately 20 percent of the pupae were parasitized. The parasites had emerged prior to the pupae density counts. On the basis of the pupal density counts, defoliation in 1963 would be expected to exceed 75 percent throughout the infestation.

Results of the egg mass survey showed the deposition of eggs differed from the pattern experienced in 1962. The length of masses and number of rows of egg masses, and consequently the number of eggs per mass, was considerably greater this year. Last year, 84 percent of the egg masses had two rows of eggs, the masses were 6.9 mm long and averaged 28.01 eggs per mass. This year, 77 percent of the egg masses had three rows, averaging 8.6 mm in length and containing 41.38 eggs.

Egg mass data, pupal case counts, and the 1963 measured defoliation are shown in the following table. The last column is the entomologist's prediction, which in each case is greater than predicted on egg mass density alone. The predictions are based primarily upon ground interpretation and observation, but are supported by high pupal case densities.

Low egg mass counts in the Fleck Summit area are thought to be due primarily to extremely heavy defoliation for the last two years; consequently, in dense stands very few suitable egg-laying sites were available at the height the samples were taken. Subsequent observations revealed an apparent higher egg mass density on the fringe type trees and on branches near the tops of trees.

In the Bounds Creek area unfortunately, branches for egg mass sampling were collected along a sheep driveway. The laboratory crew counting the egg masses found most of the branches sampled were covered with a fine dust. Subsequent investigation disclosed that large numbers of sheep had been driven over the driveway at the time the budworm moths were in flight. We believe dust in the air and on the branches is at least partly responsible for the low egg mass densities recorded from these samples.

In summary, even though three of the five sampling points show low egg mass densities we believe the entire 60,000 acre infestation on the Sawtooth will be subjected to greater than 90 percent defoliation of 1964 growth unless, of course, more than the usual amount of brood mortality occurs between now and next summer.

SAWTOOTH NATIONAL FOREST

1963 Spruce Budworm Evaluation

Sample Area	1963 damage level	1963 pupal case class	Ave. egg masses 1000 sq.in.	Ave. eggs per mass	Adjusted mean No. egg masses 1000 sq.in.	1964 damage level	
						Egg mass prediction	Expected
Fleck Summit	>90%	III	2.2	37.88	3.0	16-25%	>90%
Couch Summit	>90%	III	6.4	45.15	10.2	51-90%	>90%
Little Smokey Creek	>90%	II	6.6	40.70	9.7	51-90%	>90%
Bounds Creek	>90%	II	.4	44.63	.6	Up to 15%	50-90%
Boardman Creek	>90%	III	3.0	36.97	4.0	16-25%	>90%

DISCUSSION AND SUMMARY

Over 1.6 million acres were defoliated by the spruce budworm this year in Region Four. Of this total, more than 200,000 acres were treated by aerial application of DDT. A small test was conducted to determine the effect certain modified control procedures would have on salmon and other game fishes. The effectiveness of the insecticide Sevin against budworm larvae was tested on another portion of the spray project.

The aerial survey observers served as key personnel on the spray project and consequently were not available for aerial surveys at the time budworm damage is most plainly visible from the air. It is quite possible the delay in flying the budworm infestations caused the observers to miss some of the light to moderately defoliated infestation. Therefore, epidemic populations may be present over a larger area than the 1.6 million acres reported.

In the planning of a proposed project, it should be recognized that the acreage shown on the maps can be used only as a general guide. Because of the fact that budworm populations may be present beyond the boundary of visible damage, it usually is necessary to extend control unit boundaries somewhat to assure entomologically-sound control units.

Egg mass surveys are useful tools for predicting the next season's defoliation. However, there are many variables and uncertainties that prevent complete reliance of prediction on egg mass densities alone. For this reason it is important that trained entomologists assist in the collection of the foliage samples so that on-the-ground observations can be made. Interpretation and analysis of biological and environmental characteristics supply the evidence to support or supplement the egg mass surveys.

Experienced laboratory people trained to recognize differences in egg mass and deposition patterns can also supply data helpful in the interpretation of the findings.

Pupal case density measurements can be obtained readily while assessing the current year's damage. Pupal case densities have proven to be valuable aids in the overall interpretation of the budworm situation.

Timing is critical in the conduction of both the aerial and ground evaluations needed to correctly portray what has and is expected to happen to budworm infestations.

RECOMMENDATIONS

Direct control action on all the spruce budworm infestations except this year's control project area is justified from the entomological standpoint. Some localized spots of heavy budworm populations are present within the Targhee project area, but it does not appear desirable to respray these areas next year. They will, of course, have to be watched carefully to determine the probable trend of these isolated populations.

Control action directed against the Sawtooth infestation could be justified entomologically. However, since this population has declined rapidly on several previous occasions after rapid buildups of three or four years, it seems advisable to wait at least another year before control action is undertaken.

There is no question that all of the budworm population in the Salmon River infestation is epidemic, with a definite trend for increasing. Heavy defoliation over a majority of the infestation has occurred for the last several years, and caused severe damage to the Douglas-fir stands. Control action is more than justified for the entire Salmon River infestation. If it is not possible to treat the 1.3 million acres of infestation next year, the infestation can be divided into several entomologically sound control units.

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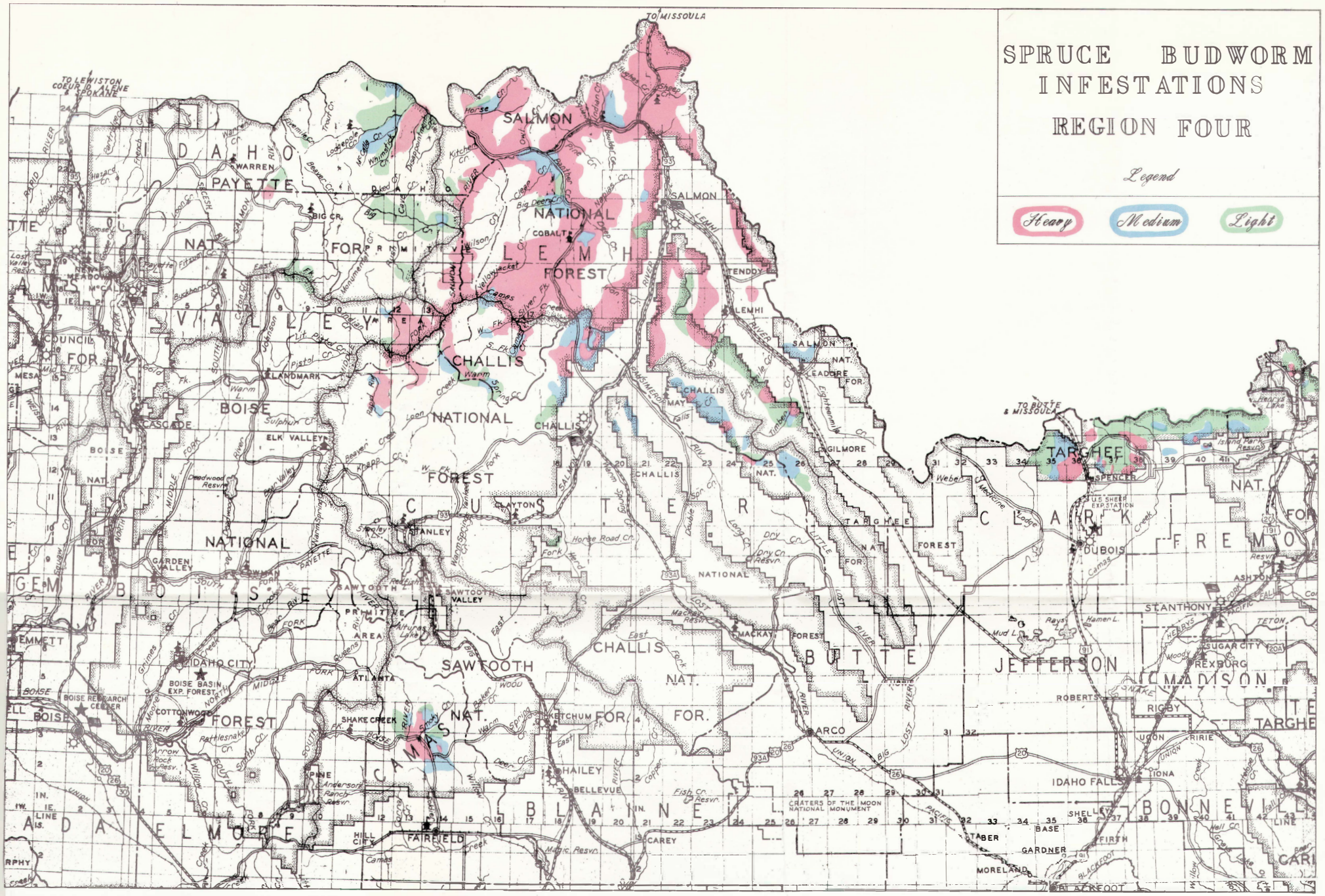
SPRUCE BUDWORM INFESTATIONS
REGION FOUR
Legend
Heavy
Medium
Light
TO MISSOULA
TO LEWISTON COEUR D'ALENE & SPOKANE
TO BUTTE & MISSOULA
SALMON
NATIONAL FOREST
LEMHI
CHALLIS
NATIONAL FOREST
BOISE NATIONAL FOREST
SAWTOOTH NAT. FOR.
SAWTOOTH PRIMITIVE AREA
CHALLIS NAT. FOR.
SAWTOOTH NAT. FOR.
SALMON NAT. FOR.
TARGHEE NAT. FOREST
CARIBOU NAT. FOR.
CRATERS OF THE MOON NATIONAL MONUMENT
IDAHO
PAYETTE
BOISE
ADA
ELMORE
CAMAS
BLAINE
BUTTE
CUSTER
LEMHI
CLARK
FREMONT
JEFFERSON
MADISON
BONNEVILLE
TETON
WARREN
BIG CR.
COBALT
TENDOY
LEADORE
GILMORE
SPENCER
DUBOIS
STANLEY
CLAYTON
GARDEN VALLEY
SAWTOOTH VALLEY
IDAHO CITY
ATLANTA
BOISE BASIN EXP. FOREST
BOISE RESEARCH CENTER
COTTONWOOD
SHAKE CREEK
KETCHUM
HAILEY
BELLEVUE
PINE
HILL CITY
FAIRFIELD
CAREY
ARCO
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ASHTON
SUGAR CITY
REXBURG
TABER
GARDNER
MORELAND
SHELLEY
FIRTH
BASE
U.S. SHEEP EXP. STATION
Deadwood Resvr.
Anderson Ranch Resvr.
Dry Cr. Resvr.
Fish Cr. Resvr.
Island Park Resvr.
Henrys Lake
Mackay Resvr.
Magic Resvr.
Arrow Rock Resvr.